Interferences in Amperometric Gas Sensors for CO

J.R. Stetter, Y. Chao

BCPS Dept. Illinois Institute of Technology
Chicago, IL 60616 USA

The oxidation of CO and H_2 on the surface of platinum under anodic operation potential has been studied for a gas sensor electrode in a special housing. Currents generated from the reactions studied are proportional to the gas concentration. Amperometric gas sensors are operated under this theory. Although many papers address the CO sensing capability, none discuss the characteristics of interference gases, in particular H_2. In the detection of CO or H_2 on platinum electrodes, interferences will occur. Certain amounts of active sites are on the surface of Pt in different types which could be Pt, PtO, or PtOH. Changing the potential will change the types of sites on the Pt working electrode. In the anodic bias region, for example +200mV vs. Pt black/air, more PtO sites will be formed compared with that of 0mV bias. CO and H_2 adsorb and oxidize on these sites with different rates and presumably with different activation energy. The following study illustrates the complex nature of interference on these surfaces and the problems introduced when these electrodes are used in chemical sensors.

For each experiment, five curves A~E are generated to estimate the interference. For a test of 0~250ppm CO with constant concentration of 300ppm H_2, they are:

A: The response in uA of CO/H_2 mixture vs. the CO concentration in ppm.

B: The response in uA for 300ppm H_2 under the same condition without CO present.

C: Calibration curve for CO in the range of 0~250ppm without H_2 present.

D: $D = A - B$

E: $E = A - C$

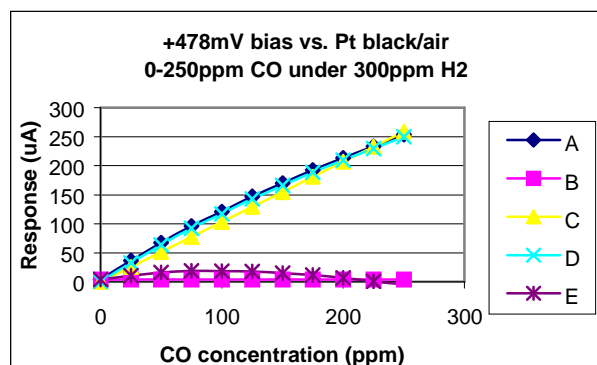If no interference exists D should equal to C and E should equal to B (Fig.1).

Fig. 1

When the CO/H_2 mixture was applied to the anodic Pt electrode, both oxidation reactions were affected by each other. The total output current is a combination of these two effects. If we suppose that the CO oxidation is unaffected by the presence of H_2, we can subtract the amount in uA contributed due to CO from the span of the mixture and compare this new number to span of H_2 alone to get the CO poisoning effect on the H_2 detection (curve D = C). However, this is not true under all our testing conditions. Only in the following cases curve D and C are close: H_2 responses at all bias settings under 10ppm and 50ppm CO, CO responses at +200mV and +478mV bias settings under 300ppm and 1000ppm H2.

CO signals are inhibited by 300pm and 1000ppm H_2 at 0mV bias also by 5000ppm H_2 at +200mv bias. Only 1000ppm CO at +450mV bias inhibits the H_2 signal. The rest cases are all additive responses. As the bias goes to anodic from 0mv to 478mV the sensitivity of CO increases 750% (from 0.138uA/ppm to 1.034uA/ppm) and that of H_2 decreases 98% (from 0.929uA/ppm to 0.019uA/ppm). Fig.2
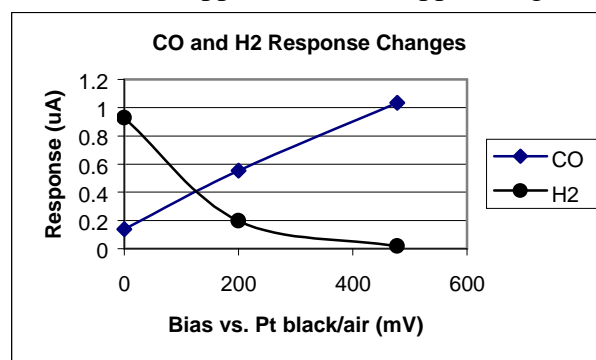

Fig. 2

This paper presents an important phenomenon, interferences between CO and H_2 on a gas sensor electrode, which often are ignored or not adequately described. The specific potential dependence of interferences between CO and H_2 is quantitatively discussed for several anodic potentials at low gas concentrations (CO<1000ppm and H_2<5000ppm) also propose possible reaction mechanism.

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